American Economic Review 2013, 103(5): 1664–1696
http://dx.doi.org/10.1257/aer.103.5.1664

Time Use During the Great Recession[†]

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Using data from the American Time Use Survey between 2003 and 2010, we document that home production absorbs roughly 30 percent of foregone market work hours at business cycle frequencies. Leisure absorbs roughly 50 percent of foregone market work hours, with sleeping and television watching accounting for most of this increase. We document significant increases in time spent on shopping, child care, education, and health. Job search absorbs between 2 and 6 percent of foregone market work hours. We discuss the implications of our results for business cycle models with home production and non-separable preferences. (*JEL* D31, E32, J22)

How do individuals allocate their lost work hours during recessions? Do individuals allocate their foregone market production to home production? What fraction of foregone work hours is allocated to job search and which categories of leisure increase during recessions? Answering these questions is important for computing the welfare costs of recessions and for interpreting the comovement of economic aggregates at business cycle frequencies. For example, a long standing issue in macroeconomics is explaining the joint movements of household spending and labor supply during recessions. Benhabib, Rogerson, and Wright (1991) and Greenwood and Hercowitz (1991) develop models where the extent to which market expenditures and market work fall during recessions depends on the willingness of households to substitute between market-produced and home-produced goods. Despite the theoretical importance of incorporating alternative time uses into models of business cycle fluctuations, data limitations have prevented a systematic analysis of how households actually substitute their time during recessions. In this paper, we fill this gap.

Using data from the American Time Use Survey (ATUS) between 2003 and 2010, we document how the allocation of time evolves over the business cycle. Up to now, such an analysis was not possible given that there was no dataset that had a large enough sample to consistently measure how households allocate their time

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[†]Go to http://dx.doi.org/10.1257/aer.103.5.1664 to visit the article page for additional materials and author disclosure statement(s).

during both a major recession and the prerecessionary period. The ATUS data allow for a comprehensive analysis of time use prior to and during the recent US recession. The 2008–2010 period is one marked by the aggregate unemployment rate rising from 5.8 percent to 9.6 percent. According to statistics of the Bureau of Labor Statistics (BLS), aggregate market work hours in the United States fell by roughly 7 percent between 2008 and 2010. The ATUS data also show that market work hours fell by a similar amount during this period.

We start our analysis by identifying the time series trends in the different time use categories. While such an analysis is useful as a descriptive measure, the short time series dimension of the data prevents us from using standard statistical methods to detrend the time series data. As a result, the time series patterns we document combine both low frequency trends as well as any potential business cycle variation. This is particularly important for the trends in both nonmarket work (home production) and leisure. During the prerecessionary 2003–2008 period, nonmarket work time was decreasing and leisure time was increasing. These patterns are extensions of the well documented trends in aggregate nonmarket work time and aggregate leisure time that started in the 1960s (Robinson and Godbey 1999; Aguiar and Hurst 2007a; Ramey 2009; Ramey and Francis 2009). A naïve comparison of the time spent on various activities before and during the recent recession would lead one to conclude that roughly 80 percent of the foregone market hours were reallocated to leisure and essentially none to nonmarket work.[1] Such a comparison is misleading. To infer the fraction of the foregone market work hours that is reallocated to each activity one would have to compare the actual time use during the recession with the time use we would have observed in the absence of the recession.

To overcome these problems, we present our formal estimates using state-level variation of business cycles. Using the variation of changes in time use across states allows us to control for common low frequency trends in time use. Using this analysis, we find that roughly 30 percent of the foregone market work hours are reallocated to nonmarket work (excluding child care). All subcategories of nonmarket work increase when market work decreases. In particular, roughly 12 percent of foregone work hours are allocated to what we refer to as core home production activities (cooking, cleaning, laundry, etc.), roughly 7 percent to increased shopping time, another 5 percent to the care of other older adults, and roughly 6 percent to home maintenance and repair. In addition, roughly 5 percent of the foregone market work hours are reallocated to child care. When we restrict our analysis only to the current recession sample (2007–2010), we find that roughly 45 percent of foregone market hours are reallocated to nonmarket work and child care combined.

Using the cross state variation of changes in market work, we show that between 2 and 6 percent of the foregone market work hours are allocated to job search. However, this represents a fairly large increase given how little time unemployed workers allocate to job search (Krueger and Mueller 2010). By contrast, we show that individuals increase significantly their time investments in their own health care, their own education, and civic activities. Specifically, roughly 12 percent of foregone market work hours are allocated to these investments.

[1] For such an analysis using the ATUS data see, for example, Justin Lahart and Emmeline Zhao, "What Would You Do With an Extra Hour?" *Wall Street Journal*, June 23, 2010.

We show that the bulk of the foregone market work time is allocated to leisure. We define leisure activities as those activities for which time and expenditure are complements. These categories include, for example, socializing with one's friends, watching television, reading, and going to the movies. We include sleep, eating, and personal care into our leisure measure given that the marginal investments in these activities may be more akin to leisure than personal maintenance. Even though roughly 80 percent of the 2.11 hours per week of market work lost between 2006–2008 and 2009–2010 showed up as additional leisure, in the cross section of US states in which we can control for aggregate trends, leisure activities absorb only roughly 50 percent of a given decrease in market work. Additionally, a large fraction of this reallocation is directed toward sleep (more than 20 percent of foregone market work hours).

We decompose changes in time use into an extensive and an intensive margin. We find that between the prerecessionary period (2006–2008) and the recession (2009–2010), 74 percent of the decline in total market work hours is accounted for by the increase in nonemployment and 26 percent by the decline in market work hours per employed person. If the responsiveness of alternative time uses to declining market work hours is equal along these margins, then a simple decomposition suggests that 74 and 26 percent of the change in each time use category is accounted for by the increase in nonemployment and the decrease in market work hours of employed persons respectively. We show that the responsiveness of time use to changes in market work is remarkably stable across different labor market states. Therefore, the simple decomposition does a good job in allocating changes in time use to the various margins of adjustment.

We show that the responsiveness of time use to changes in market work is relatively stable across genders. However, the responsiveness of time use to changes in market work differs noticeably between married and singles. In particular, in the married sample, roughly 42 percent of the foregone market work hours is allocated to nonmarket work and child care. The corresponding estimate in the singles sample is only 15 percent. As we show, this significant difference is offset by increases in sleeping time and education and not by additional job search by singles. Finally, we demonstrate the robustness of our results to various sensitivity exercises. Changing the demographic composition of our sample, accounting for the intratemporal and intertemporal correlation of errors across and within states, correcting for nonclassical measurement error, instrumenting for changes in market work, controlling for demographic trends and housing shocks, and allowing for state-specific fixed effects and state-specific time trends do not change our base results in any meaningful way.

Our empirical results are informative for a large class of macroeconomic models. While macroeconomic models with home production have been successful in explaining a number of facts pertaining to aggregate fluctuations, until today there has been no systematic evidence that compares the allocation of time over the business cycle in these models with the actual time use behavior of households. Alternatively, models with non-separable preferences between consumption and leisure are important for understanding a variety of macroeconomic outcomes, such as unemployment (e.g., Hall 2009a), the government spending multiplier (e.g., Christiano, Eichenbaum, and Rebelo 2011), and the dynamics of the trade balance (e.g., Correia, Neves, and Rebelo 1995). Our results are supportive of home production models that assume a

high elasticity of substitution between home production and market production or of reduced-form models of home production that assume strong complementarities between consumption and labor in the utility function. This is because our estimates suggest that, in response to declining market work hours, nonmarket work is three to four times a more elastic margin of substitution than leisure. By contrast, we find no evidence that individuals alter their time allocated to home production in a way that is systematically correlated with aggregate market work hours, holding constant their market work. This suggests that shocks to the home production sector have not been an important driver of the US business cycle between 2003 and 2010.

Our work contributes to various other strands of literature. First, there has been a recent flurry of articles that have used time diaries to address a variety of economic questions. Recent research has documented substantial changes in the allocation of time over the past half century. Aguiar and Hurst (2007a) show that, since the mid-1960s, aggregate time spent on home production has declined while aggregate time spent on leisure has increased. Additionally, research has also documented the extent to which the allocation of time evolves over the lifecycle (Ghez and Becker 1975; Aguiar and Hurst 2007b; Hurd and Rohwedder 2008). Households dramatically increase their time spent on home production allowing them to reduce the market expenditures necessary to sustain consumption during their retirement years. Guryan, Hurst, and Kearney (2008) and Ramey and Ramey (2010) have explored the importance and changing nature of parental inputs into child care. Lee, Kawaguchi, and Hamermesh (2012) use time diaries from Japan and Korea to analyze the effects of legislated labor demand shocks on time use, finding that very little of the reduction in market time is reallocated to home production. Morrill and Pabilonia (2011) use 2003–2009 data from the ATUS and find that the leisure time that families spend together displays a U-shaped relationship with the state-level unemployment rate. Finally, there is an emerging literature on the time use of the unemployed. Recent work by Aguiar and Hurst (2009) has analyzed the time use behavior of the unemployed, while Krueger and Mueller (2010) explore the relationship between time spent on job search and unemployment benefit generosity. Guler and Taşkin (forthcoming) documents how time spent on home production by the unemployed varies across states with unemployment benefits.

Because of data limitations, however, there has been no systematic analysis of the allocation of time at business cycle frequencies. Burda and Hamermesh (2010) use ATUS data from the nonrecessionary period 2003–2006 to explore the relationship between metro-level unemployment, market work, and home production. Our paper differs along two dimensions. First, we measure how foregone market work is allocated to alternate time uses both during nonrecessionary periods and during recessions. Second, and more crucially, we measure how state differences in *changes* in market work imply differences in changes in other time uses, rather than how individual differences in *levels* of market work imply differences in levels of other time uses. Specifically, Burda and Hamermesh (2010) separately regress individual market work and individual nonmarket work on the region-specific current unemployment rate (and in some specifications also controlling for average unemployment rate during the past years). By comparing the coefficients from these regressions, they conclude that roughly 75 percent of foregone market work hours are allocated to home production. In contrast, we regress changes in state nonmarket work on changes in state market

work, which allows us to control for common aggregate trends and state-specific fixed effects in the level of time use. Using this strategy, we estimate that roughly 30 percent of foregone market work hours are allocated to nonmarket work.

I. Data

We use data from the 2003–2010 waves of the ATUS. The ATUS is conducted by the BLS and individuals in the sample are drawn from the exiting sample of the Current Population Survey (CPS). On average, individuals are sampled approximately three months after completion of their final CPS survey. At the time of the ATUS survey, the BLS updates the respondent's employment and demographic information. Each wave is based on 24-hour time diaries where respondents report the activities from the previous day in detailed time intervals. Survey personnel then assign the activities reported by the individual to a specific category in the ATUS's set classification scheme which is comprised of over 400 detailed time use categories. For more information on the types of activities that are recorded in the ATUS see Hamermesh, Frazis, and Stewart (2005). The 2003 wave of the survey includes over 20,000 respondents, while each of the 2004–2010 waves include roughly 13,000 respondents.

We segment the allocation of time into seven broad time use categories. We construct the categories to be mutually exclusive and to sum to the individual's entire time endowment. The seven categories we look at are described in detail below and are based on the response for the primary time use activity. A full list of the time use categories analyzed in this paper is available in the online Appendix that accompanies our paper.[2]

Market work includes all time spent working in the market sector on main jobs, second jobs, and overtime, including any time spent commuting to or from work and time spent on work related meals and activities. We separate from total market work the time spent on job search and the time spent on other income-generating activities outside the formal sector. This allows us to study the extent to which households spend time looking for employment or substitute time from the formal to the informal sector.

Other income-generating activities include all time spent on activities such as hobbies, crafts, food preparation, and performances that generate income and the time spent on income-generating services such as babysitting and home improvements for pay.

Job search includes all time spent by the individual searching for a job. As with all time use categories, we include the time spent commuting associated with job search as part of time spent on job search. Job search includes, among others, activities such as sending out resumes, going on job interviews, researching details about a job, asking about job openings, or looking for jobs in the paper or on the Internet.

Child care measures all time spent by the individual caring for, educating, or playing with their children. Guryan, Hurst, and Kearney (2008) show that the time series and lifecycle patterns of time spent on child care differ markedly from the patterns of time spent on home production. In particular, the income elasticity of time spent on child care is large and positive while the income elasticity of time spent on home

[2] We recognize that, in some instances, the classification of time into the various categories may change depending on whether the economy is in recession. For this reason, we always report results both for our time use aggregates and for the specific subcategories that constitute the aggregates.

production is large and negative. Additionally, some components of child care have a direct leisure component. For example, according to Juster (1985), individuals report spending time playing with their children as among their most enjoyable activities. On the other hand, there is a well developed market for child care services that parents are willing to pay for to reduce their time spent with their children. Given these dichotomies, we treat child care as a separate category.

Nonmarket work (home production) consists of four subcategories: core home production, activities related to home ownership, obtaining goods and services, and care of other adults. Core home production includes any time spent on meal preparation and cleanup, doing laundry, ironing, dusting, vacuuming, indoor household cleaning, cleaning or repairing vehicles and furniture, and activities related to the management and the organization of the household. Home ownership activities include time spent on household repairs, time spent on exterior cleaning and improvements, time spent on the garden, and lawn care.[3] Time spent obtaining goods and services includes all time spent acquiring any goods or services (excluding medical care, education, and restaurant meals). Examples include grocery shopping, shopping for other household items, comparison shopping, coupon clipping, going to the bank, going to a barber, going to the post office, obtaining government services, and buying goods online. Finally, care of other adults includes any time supervising and caring for other adults, preparing meals and shopping for other adults, helping other adults around the house with cleaning and maintenance, and transporting other adults to doctors offices and grocery stores.

Leisure includes most of the remaining time individuals spend that is not on market work, nonmarket work, job search, or child care. Specifically, we follow Aguiar and Hurst (2007a, 2009) and try to isolate goods for which time and expenditure are complements. The time spent on activities which comprise leisure include time spent watching television, time spent socializing (relaxing with friends and family, playing games with friends and family, talking on the telephone, attending and hosting social events, etc.), time spent exercising and on sports (playing sports, attending sporting events, exercising, running, etc.), time spent reading (reading books and magazines, reading personal mail and e-mail, etc.), time spent on entertainment and hobbies that do not generate income (going to the movies or theater, listening to music, using the computer for leisure, doing arts and crafts, playing a musical instrument, etc.), time spent with pets, and all other similar activities. We also include in our leisure measure activities that provide direct utility but may also be viewed as intermediate inputs such as time spent sleeping, eating, and personal care. While we exclude own medical care, we include activities such as grooming, having sex, and eating at home or in restaurants.

Other includes all the remaining time spent on one's education, time spent on civic and religious activities, and time spent on one's own medical and health care. Some of this time can be considered home production as well, as they represent time investments into the stock of health and human capital.

[3] With respect to the long run trends in time use, there is a debate about whether time spent gardening or spending time with one's pets should be considered as home production or leisure. See, for example, Ramey (2007). Given that the ATUS time use categories can be disaggregated into finer subcategories, in this paper we include gardening and lawn care in nonmarket work and we include pet care into leisure.

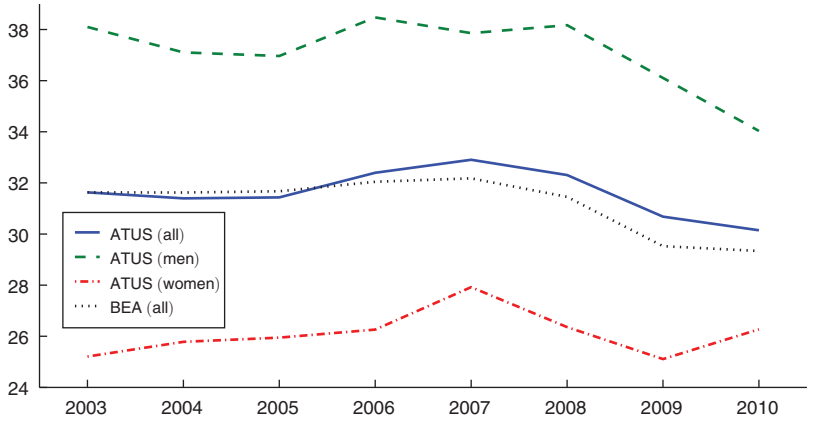

FIGURE 1. MARKET WORK

Notes: The figure shows annual estimates for average market work time for the whole sample, the sample of men, and the sample of women. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff. In the same figure we also plot BEA estimates of total hours worked divided by US working-age population. The BEA series has been standardized so that it equals the ATUS series in 2003.

For our main sample, we include all ATUS respondents between the ages of 18 and 65 (inclusive) who had complete time use record. Specifically, we exclude any respondent between the age of 18 and 65 who had any time that was not able to be classified by the ATUS staff. In total, we have 76,203 individuals in our base sample. We use the sample weights provided by the ATUS to aggregate responses to either year or state-year totals. Table B.1 in the online Appendix provides summary statistics of the various time use categories for the total sample and for men and women separately.

II. Time Series Analysis of Time Use

Figures 1, 2, and 3, and Tables 1 and 2 provide descriptive results for the time series analysis of different time use categories for our entire base sample as well as the subsamples by gender. Figure 1 shows the patterns of market work. For comparison, in the same figure we also plot market work hours per capita from the US Bureau of Economic Analysis (BEA). Between 2007 and 2010, total market work fell by 8.38 percent from 32.90 hours per week to 30.14 hours per week for the average individual in our ATUS sample. As shown in the figure, the decline in work hours in our ATUS sample matches well with the decline in the BEA series. This decline is also close to the 8.06 percent decline in market work hours as reported by the US Bureau of Labor Statistics (BLS).[4] Most of the decrease in market work occurred between 2008 and 2010. The 6.68 percent decline in market work hours in our ATUS sample during

[4] We stress that the change in the unemployment rate in the ATUS between 2008 and 2010 matches well with the change in the unemployment rate in the BLS. Specifically, the BLS reports an increase in the unemployment rate from 5.8 percent to 9.6 percent. In the ATUS, the unemployed divided by the total respondents excluding retirees, students, and other persons out of the labor force increases from 5.7 percent to 9.3 percent.

this period also matches well with the 6.90 percent decline reported by the BLS. Since the largest fraction of the decrease in market work hours and of the increase in unemployment occurred between 2008 and 2009, in our tables we treat years prior to 2009 as being the prerecessionary period which differs slightly from the NBER recession dating (December 2007). The time use data also show that market work hours have declined more for men than for women during this time period. We find that market work for men decreased by 10.83 percent between 2008 and 2010, while market work for women decreased by only 0.32 percent between 2008 and 2010.

To smooth out potential measurement error in year to year variations, Tables 1 and 2 report the time use in various categories averaged over 2003 through 2005 (column 1), averaged over 2006 through 2008 (column 2), and averaged over 2009 and 2010 (column 3). In column 4, we report the unconditional difference between the 2006–2008 average (prerecessionary period) and the 2009–2010 average (recessionary period). In column 5, we report the conditional difference in the time spent on the given category between the prerecessionary period and the recessionary period. To get the conditional differences, we use the underlying micro data from the 2006–2010 period and regress the time spent by an individual on a given category on a recessionary period (2009–2010) dummy and demographic controls measuring the age of the individual (via five year age dummies), the education of the individual (via four education dummies), the race of the individual, the marital status of the individual, the gender of the individual, and a dummy variable indicating whether or not the individual has a child. The controls are included to see if the sample composition of the ATUS was changing over time. Given that we are using the harmonized individual weights provided by the ATUS for each year, controlling for demographics has negligible effects on our estimated time series changes in time use. For each time use category, we present the *p*-values associated with the unconditional and the conditional difference between 2006–2008 and 2009–2010 in the online Appendix (Table B.2). For market work, other income-generating activities, job search, leisure, TV watching, and sleep, the changes between the two periods are significant at the 5 percent level.

The rest of Tables 1 and 2 and in Figures 2 and 3 show the time series evolution of categories other than market work. Figure 2 shows the evolution of leisure time over our sample. A few things are of note. First, men allocate more of their time to leisure than women do for each year in our sample. Second, for the combined sample of men and women and for the sample of men, there seems to be an upward trend in leisure during the 2003–2008 period. Third, between 2008 and 2010, there were large increases in leisure time for both men and women, even relative to the potential trend. Conditional on demographic changes, the entire sample experienced a 1.69 hours increase in leisure time between the prerecessionary period (2006–2008) and the recessionary period (2009–2010). Nearly all of this increase was concentrated in two leisure categories, television watching and sleep. Men experienced a 1.49 hours increase in leisure conditional on demographic changes between the prerecessionary period and the recessionary period. Again, this increase was concentrated in sleep and television watching.

Figure 3 shows the evolution of nonmarket work between 2003 and 2010 for all individuals in our sample and then for men and women separately. Like with leisure, both men and women seem to have experienced trends in nonmarket work time during the 2003–2008 period. For example, women's nonmarket work hours

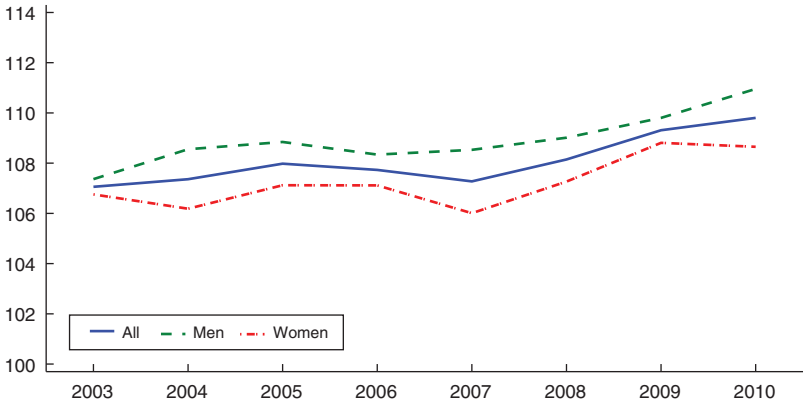

FIGURE 2. LEISURE

Notes: The figure shows annual estimates for average leisure time for the whole sample, the sample of men, and the sample of women. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff.

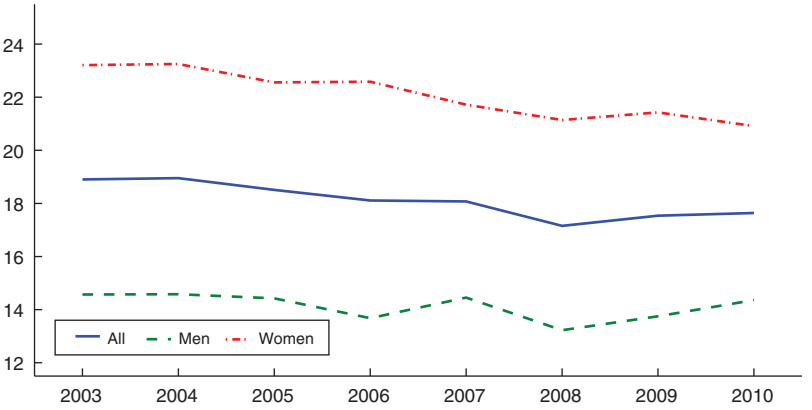

FIGURE 3. NONMARKET WORK

Notes: The figure shows annual estimates for average nonmarket work time for the whole sample, the sample of men, and the sample of women. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff.

declined by nearly 2 hours per week between 2003 and 2008. Men's nonmarket work hours declined by almost 1 hour per week between the 2003 to 2008 period. The decrease in nonmarket work time and the increase in leisure are directly related. As shown by Aguiar and Hurst (2007a), the increase in leisure despite constant market work hours between 1965 and 2003 was also made possible by declining time spent on nonmarket work. In other words, the movements in leisure and nonmarket work in the ATUS between 2003 and 2008 seem representative of broader trends in the United States that occurred in the 1965–2003 period. In addition, Table 1 shows that all subcategories of nonmarket work (core home production, home ownership activities, obtaining goods and services, and others care) experienced declines

TABLE 1—TIME USE BY PERIOD (*All sample*)

Time use category	Average 2003–2005 (1)	Average 2006–2008 (2)	Average 2009–2010 (3)	Difference unconditional 2009–2010 versus 2006–2008 (4)	Difference conditional 2009–2010 versus 2006–2008 (5)	Difference 2009–2010 versus trend (6)
Market work	31.48	32.53	30.41	−2.11	−2.14	−0.81
Other income-generating activities	0.16	0.16	0.24	0.07	0.07	0.02
Job search	0.20	0.27	0.42	0.15	0.14	0.03
Child care	4.84	4.57	4.47	−0.09	0.01	0.02
Nonmarket work	18.78	17.78	17.58	−0.19	−0.09	0.19
Core home production	9.56	9.38	9.38	0.00	0.10	0.07
Home ownership activities	2.40	2.17	2.11	−0.05	−0.04	0.02
Obtaining goods and services	5.20	5.03	4.84	−0.18	−0.19	0.01
Others care	1.61	1.19	1.24	0.04	0.04	0.10
Leisure	107.46	107.71	109.55	1.83	1.69	0.44
TV watching	17.03	17.55	18.57	1.01	1.00	0.14
Socializing	7.82	7.59	7.59	0.00	−0.02	0.05
Sleeping	59.30	59.54	60.18	0.64	0.68	0.18
Eating and personal care	13.36	13.26	13.32	0.05	0.02	−0.01
Other leisure	9.93	9.74	9.86	0.11	0.00	0.07
Other	5.03	4.95	5.29	0.34	0.30	0.11
Education	2.11	2.00	2.16	0.16	0.14	0.07
Civic and religious activities	1.93	1.98	2.15	0.16	0.15	0.05
Own medical care	0.98	0.96	0.97	0.00	0.00	−0.01

Notes: Columns 1–3 present estimates of the average hours per week spent on each time use category by sample period. Column 4 shows the unconditional difference in each time use category between the period 2009–2010 and the period 2006–2008. Column 5 presents the conditional difference in each time use category between the period 2009–2010 and the period 2006–2008. The conditional difference is the coefficient for the dummy variable on the 2009–2010 period in a regression of individual time spent on a given category on the dummy and demographic controls (age, education, race, gender, marriage status, kids). Column 6 presents the difference between the observed average value of each time use category in 2009–2010 and the linear trend of each time use category in 2009–2010.

during the 2003–2008 period. By contrast, the time series analysis suggests that nonmarket work hours were roughly constant between the recession years and the prerecessionary period both for the entire sample and for men.

The increase in leisure and the decrease in nonmarket work before the recession can cause problems with respect to interpreting the effects of the recession on time use. The change in leisure and nonmarket work during the recession includes both low frequency trends over nonrecessionary periods that could have continued during the recession and business cycle fluctuations in time use. The correct comparison is what various time use categories would have been in 2009 and 2010 absent the recession compared to what they actually are during 2009 and 2010.

Interestingly, the estimates we find from our cross state sample in Section III are not that different from what we find using a simple linear trend between 2003 and 2010 to isolate the cyclical component of each time use category. Figure 4 shows the annual estimates for average market work, leisure, and nonmarket work and their linear trends. We can use the linear trends as counterfactual time series to calculate how foregone market work hours were reallocated to other time uses during the recent recession. This is shown in column 6 of Tables 1 and 2 for the aggregate

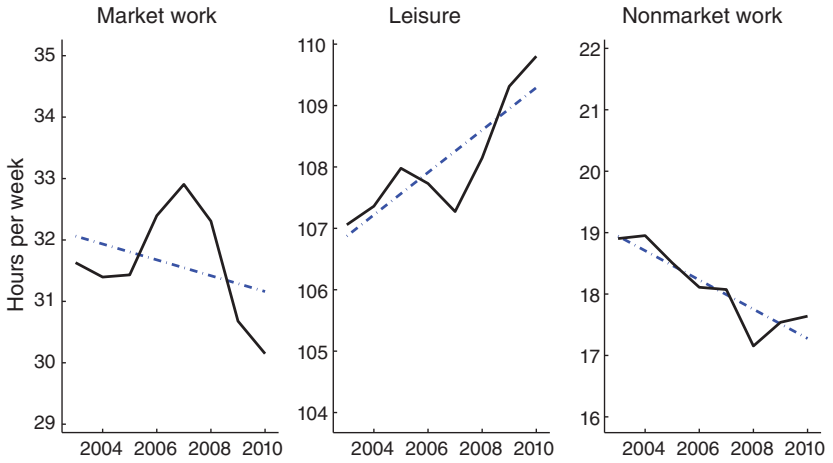

FIGURE 4. OBSERVED TIME USE AND LINEAR TREND OF TIME USE

Notes: The solid line shows the year-to-year estimates for average market work, leisure, and nonmarket work from the ATUS sample. The dashed line shows the linear trends in these time use categories.

sample and for men respectively. In the aggregate sample, we find that 24 percent of the decline in market work hours during the recession has been allocated to nonmarket work and 54 percent to leisure. In the sample of men, the corresponding estimates are 24 percent and 32 percent respectively.[5] These estimates are close to our results when we use the cross state variation of business cycles to estimate how foregone market work hours are allocated to alternative time uses. However, they differ dramatically from the estimates one would obtain without controlling for the trend. Looking at column 5 of Table 1, a naïve analysis may conclude that nearly 80 percent of the foregone market work hours during the recession were reallocated to leisure (i.e., 1.69 hours per week out of the 2.14 hours per week) and essentially none to nonmarket work. However, given the upward trend in leisure and the declining trend in nonmarket work before the recession, such a conclusion is premature.

III. Identifying Business Cycle Effects from Cross State Variation

The above analysis indicates that the interpretation of changes in time use during a recession depends on how one controls for low frequency trends. The standard time series method for dealing with such low frequency trends is to filter the data so as to remove the trends. A linear trend is a simple first step. However, the time trend may have strong nonlinearities that are not apparent given the short time frame of our sample. This fact is what necessitates our alternate approach of using the variation of business cycles across states to remove these aggregate trends. We use changes in time use categories (as opposed to levels) to control for any state-specific

[5] These calculations are not sensitive to excluding 2009 and 2010 when estimating the linear trend. We emphasize that the trend decrease in nonmarket work and the trend increase in leisure that we calculated in Figure 4 are consistent with longer term trends documented in Aguiar and Hurst (2007a).

TABLE 2—TIME USE BY PERIOD (*Men sample*)

Time use category	Average 2003–2005 (1)	Average 2006–2008 (2)	Average 2009–2010 (3)	Difference unconditional 2009–2010 versus 2006–2008 (4)	Difference conditional 2009–2010 versus 2006–2008 (5)	Difference 2009–2010 versus trend (6)
Market work	37.38	38.16	35.10	−3.06	−2.83	−0.94
Other income-generating activities	0.15	0.15	0.25	0.09	0.09	0.03
Job search	0.27	0.37	0.56	0.19	0.18	0.03
Child care	2.90	2.82	2.98	0.16	0.21	0.05
Nonmarket work	14.52	13.78	14.04	0.25	0.25	0.23
Core home production	5.53	5.75	5.83	0.07	0.05	−0.02
Home ownership activities	3.21	2.95	2.93	−0.01	−0.00	0.02
Obtaining goods and services	4.13	3.93	4.05	0.11	0.11	0.11
Others care	1.64	1.13	1.21	0.07	0.08	0.12
Leisure	108.25	108.62	110.36	1.73	1.49	0.31
TV watching	18.61	19.29	20.33	1.04	0.96	0.14
Socializing	7.48	7.24	7.23	−0.01	−0.03	0.03
Sleeping	58.51	58.88	59.39	0.50	0.47	0.07
Eating and personal care	12.99	12.76	12.84	0.08	0.07	−0.03
Other leisure	10.64	10.43	10.54	0.11	0.01	0.09
Other	4.49	4.07	4.69	0.62	0.59	0.31
Education	1.97	1.54	1.98	0.43	0.42	0.22
Civic and religious activities	1.68	1.75	1.88	0.13	0.13	0.06
Own medical care	0.83	0.77	0.82	0.04	0.04	0.03

Notes: Columns 1–3 present estimates of men's average hours per week spent on each time use category by sample period. Column 4 shows the unconditional difference in each time use category between the period 2009–2010 and the period 2006–2008. Column 5 presents the conditional difference in each time use category between the period 2009–2010 and the period 2006–2008. The conditional difference is the coefficient for the dummy variable on the 2009–2010 period in a regression of individual time spent on a given category on the dummy and demographic controls (age, education, race, marriage status, kids). Column 6 presents the difference between the observed average value of each time use category in 2009–2010 and the linear trend of each time use category in 2009–2010.

time-invariant effect in time use. As one would expect given the low frequency trends that we described above, we find that the simple time series analysis overestimates the substitution of foregone market work hours to leisure and underestimates the substitution of foregone market work hours to nonmarket work.

We start by defining state-level aggregates of our different time use categories:

$$\tau_{st}^{j} = \sum_{i=1}^{N_{st}} \left(\frac{w_{ist}}{\sum_{i=1}^{N_{st}} w_{ist}} \right) \tau_{ist}^{j}, \tag{1}$$

where τ_{ist}^{j} is hours per week that individual i from state s during period t spent on time use category j. We denote by N_{st} the number of individuals in our sample from state s during time t. When computing the state averages, we weight the data using the ATUS sampling weights w_{ist}. The time use categories denoted by j are the same as the ones we show in Table 1. Our states include all 50 states plus the District of Columbia, $s = 1, \ldots, 51$. For our base analysis, we divide our sample into four nonoverlapping two-year time periods (2003–2004, 2005–2006, 2007–2008, and 2009–2010), i.e., $t = 1, 2, 3, 4$. The ATUS is designed to be representative at the

national level but the ATUS weighting procedure does not guarantee that the sample will be representative of the population within each separate state during each year. Averaging over the two years helps to mitigate measurement error in our dataset due to sampling variation within the survey at the state level. Using data from all state-period pairs yields 204 observations (51 states multiplied by the four two-year time periods).

To assess how foregone market work hours are reallocated across different time use categories, for each time use category j we estimate the following base regression:

$$\Delta\tau_{st}^{j} = \alpha^{j} - \beta^{j}\Delta\tau_{st}^{market} + \varepsilon_{st}^{j}, \tag{2}$$

where $\Delta\tau_{st}^{j}$ is the change in hours per week spent on time use category j for the average individual in state s between period $t-1$ and period t, and $\Delta\tau_{st}^{market}$ is the change in market work hours for the average individual in state s between period $t-1$ and period t.

The coefficient of interest is β^{j} which measures the fraction of foregone market hours allocated to time use j, identified from the cross state variation of changes in market work. We stress that we are not assuming that market hours are moving exogenously relative to other time allocation decisions, and indeed they are likely to be chosen simultaneously. The coefficients β^{j} are not structural parameters, but simply accounting devices that measure how each activity covaries with market work once we control for aggregate trends. Since our time use categories are mutually exclusive and sum to the total endowment of time, we have $\sum_{j}\beta^{j} = 1$. To make the interpretation of the results more transparent, in all tables below we multiply the coefficients by 100.

Before proceeding, we discuss two criteria that are necessary to isolate the cyclical decomposition of foregone market work hours to other time use categories using the cross state variation. First, there must be variation of changes in market work hours across states. In the online Appendix (Table B.3) we present descriptive statistics for $\Delta\tau_{st}^{market}$ which show substantial variation both for our pooled sample and for each separate subperiod. In the online Appendix (Table B.4) we also show descriptive statistics for the changes in the state-level unemployment rate. Second, we need to assume that there are no state-specific low frequency trends in time uses. The evidence we have mitigates our concerns that differential low frequency trends in time use at the state level are biasing our decompositions. With the aggregate data we were concerned that low frequency decreases in nonmarket work and low frequency increases in leisure were contaminating our time series analysis. However, the aggregate time series patterns are found in many states. In the online Appendix (Table B.5) we present summary statistics of the distribution of changes in leisure and nonmarket work between 2003–2004 and 2007–2008. More than 80 percent of states experienced decreases in the time spent on nonmarket work hours and roughly 60 percent of states experienced increases in the time spent on leisure. This suggests that it may be possible to control for an aggregate trend (captured by the constant α^{j} in our regression) by using the cross state variation. In addition, in Section IVE, we control for state-specific fixed effects and state-specific linear time trends. As expected from the fact that the aggregate trend in time use is found in many states, introducing state-specific fixed effects and state-specific linear trends in the change in time use does not alter our results in any meaningful way.

TABLE 3—STATE SAMPLE: BASE RESULTS

Time use category	Sample average (1)	$\hat{\beta}$ unweighted (2)	$\hat{\beta}$ SE (3)	$\hat{\beta}$ weighted (4)	$\hat{\beta}$ SE (5)	$\hat{\beta}$ demographics (6)	$\hat{\beta}$ time D_t (7)	$\hat{\beta}$ demo + D_t (8)
Other income-generating activities	0.13	0.31	0.54	0.78	0.70	0.99	0.56	0.82
Job search	0.21	1.07	0.70	1.29	0.70	1.26	0.97	0.73
Child care	3.40	1.09	2.91	4.67	2.33	4.06	5.52	4.98
Nonmarket work	13.28	26.40	7.31	30.11	3.58	28.38	31.30	29.68
Core home production	6.92	11.53	2.45	11.67	2.04	10.79	12.61	11.80
Home ownership activities	1.64	6.35	6.04	6.05	2.96	6.78	6.84	7.47
Obtaining goods and services	3.70	4.09	1.78	7.47	2.56	5.84	7.95	6.61
Others care	1.00	4.42	2.72	4.90	1.98	4.95	3.91	3.78
Leisure	79.22	56.99	7.97	50.89	4.79	52.16	49.76	51.09
TV watching	12.90	9.48	5.43	11.62	3.57	12.60	12.19	12.35
Socializing	5.63	4.90	4.47	5.14	2.82	3.88	3.85	3.24
Sleeping	43.70	21.31	4.93	21.42	3.64	20.82	20.55	19.42
Eating and personal care	9.76	0.05	2.10	−1.77	2.83	−1.23	−2.28	−1.81
Other leisure	7.21	21.23	6.08	14.47	3.92	16.08	15.44	17.89
Other	3.71	16.30	4.26	12.24	3.48	13.12	11.86	12.68
Education	1.47	10.18	4.89	5.86	3.47	7.19	5.07	6.44
Civic and religious activities	1.52	1.25	1.62	1.94	1.39	2.10	1.97	2.14
Own medical care	0.71	4.85	1.61	4.43	1.74	3.81	4.82	4.09

Notes: All coefficients are multiplied by 100. Column 1 shows the average time spent on each time use category when individuals are not working. The rest of the table presents the estimated coefficients $\hat{\beta}^j$ from regression (2). Column 2 presents ordinary least squares estimates. Column 3 presents the standard errors associated with the estimated coefficients of column 2. Standard errors are clustered at the state level. Column 4 presents weighted least squares estimates, where each observation is weighted with the state's population. Column 5 presents the standard errors associated with the estimated coefficients of column 4. Standard errors are clustered at the state level. Column 6 presents weighted least squares estimates when demographic controls are included in the regression. Column 7 presents weighted least squares estimates when the time dummies D_t are introduced in the baseline regression. Column 8 presents weighted least squares estimates when the demographic controls of column 6 and the time dummies of column 7 are included in the regression.

Table 3 presents the base results. Column 1 shows the average share of time that the average individual in our sample spends on each time use category when not working. For example, the average individual spends roughly 80 percent of her nonworking time on leisure and roughly 13 percent on nonmarket work. In column 2 we present the estimated coefficients from regression (2) and in column 3 we present the associated standard errors which are clustered at the state level. In column 4 we use weighted least squares to estimate equation (2) and in column 5 we present the associated standard errors. States are weighted with their population. We prefer the weighted least squares estimates of column 4 relative to the unweighted estimates of column 2 because measurement error at the state level is likely to be an issue. By weighting observations, we put less weight on smaller states for which sampling error is likely to be the most problematic. As the comparison between column 3 and column 5 shows, the weighted least squares estimated coefficients have almost always smaller standard errors. We discuss measurement error issues in more detail in Section IVB.

To verify that outliers are not driving our results, Figures 5 and 6 show the simple scatter plots of $\Delta\tau_{st}^{market}$ against $\Delta\tau_{st}^{nonmarket}$ and $\Delta\tau_{st}^{leisure}$. The weighted least squares regression line fitting the data in the scatter plot is also shown. The regression line in the scatter plots is analogous to column 4 of Table 3. As seen

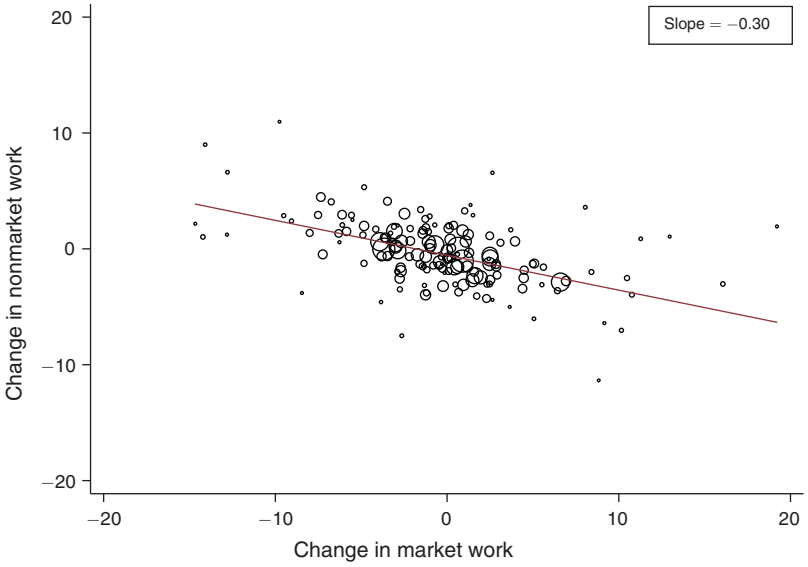

FIGURE 5. CROSS STATE VARIATION: NONMARKET WORK VERSUS MARKET WORK

Notes: The horizontal axis shows changes in nonmarket work hours in the pooled sample of states. The vertical axis shows changes in market work hours in the pooled sample of states. States are weighted by population size.

from the two figures, a one-hour per week reduction in market work increases time spent on nonmarket work by roughly 0.30 hours per week and increases time spent on leisure by roughly 0.51 hours per week.

Columns 6, 7, and 8 present estimates when we control for changes in demographic variables $\Delta \mathbf{X}_{st}$ at the state level, estimates when we control for a vector $\mathbf{D}_t$ of time dummies, and estimates when we control for $\Delta \mathbf{X}_{st}$ and $\mathbf{D}_t$ simultaneously. In column 6, the vector $\Delta \mathbf{X}_{st}$ includes the state-level change between period $t - 1$ and period t in the fraction of the sample that is included in five different age bins, the change between period $t - 1$ and period t in the fraction of the sample that is included in four different education bins, the change between period $t - 1$ and period t in the fraction of the sample within the state that is male, the change between period $t - 1$ and period t in the fraction of the sample within the state that is married, the change between period $t - 1$ and period t in the fraction of the sample within the state that has a child, and the change between period $t - 1$ and period t in the fraction of the sample within the state that is black.[6] We include these controls to capture the potential that the demographic composition of the state is changing over time either due to migration or due to sampling variation. In column 7, we include the time dummies to ensure that our identification of how market work hours are reallocated to different time use categories is coming from the cross state differences and not the common trend (i.e., we are looking at the "within period" variation of the sample). As seen from the three last columns of

[6] Estimates and standard errors are similar when, alternatively, we first remove the influence of demographics on time use at the individual level and then aggregate at the state level (Table B.8 in the online Appendix).

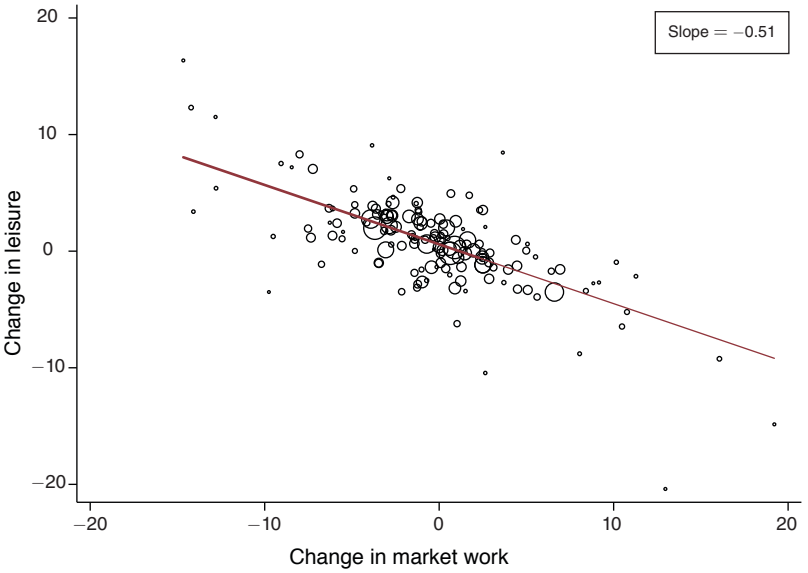

FIGURE 6. CROSS STATE VARIATION: LEISURE VERSUS MARKET WORK

Notes: The horizontal axis shows changes in leisure hours in the pooled sample of states. The vertical axis shows changes in market work hours in the pooled sample of states. States are weighted by population size.

Table 3, our estimates of the fraction of foregone market work that is reallocated to each alternative time use category is unchanged in response to controlling for the $\Delta \mathbf{X}_{st}$ vector of state-level demographic variables, for the time dummies $\mathbf{D}_t$, or for both simultaneously.

Based on columns 4 and 6–8 in which states are weighted by their population, we conclude that roughly 30 percent of foregone market work hours are allocated to nonmarket work while slightly more that 50 percent of foregone market work hours are allocated to leisure. Table 3 also decomposes changes in nonmarket work and leisure into its subcomponents. In particular, almost two-thirds of the increase in nonmarket work is due to an increase in the time allocated to core home production activities (e.g., cooking, cleaning, laundry) and shopping. As seen in Aguiar and Hurst (2007b), the shopping margin is also important in explaining the movements in nonmarket work in response to changes in market work over the lifecycle. Although we treat it as a separate category, more than 4 percent of the foregone market work hours are allocated to child care.

Roughly two-thirds of the increase in leisure associated with the decline in market work are concentrated in television watching and sleeping. We do not find that socializing (spending time with one's spouse, extended family, and friends) increases significantly during recessions. However, we do find that the relatively small category "other leisure" absorbs roughly 15 percent of the foregone market work hours. Other leisure is a broad category that includes various leisure activities other than sleeping, eating, personal care, socializing, and watching TV. Of these subcategories, "entertainment other than TV" (e.g., listening to music and playing with the computer), "exercising, sports, and recreation," and "hobbies" (arts, collecting, writing)

that do not generate income comprise the bulk of the movement in the "other leisure" category. Specifically, each of the first two subcategories absorbs roughly 5 percent of the decline in market work hours, and the latter absorbs another 2 percent.

Table 3 also shows that no more than 2 percent of foregone market work hours are allocated to job search. Additionally, work in the informal sector absorbs at most 1 percent of the foregone market work hours. The estimated effect of job search is quite different than the 6.5 percent estimate shown in column 5 of Table 1 using the time series variation. As column 6 of Table 1 shows, part of this difference seems to be driven by aggregate trends. That is, once we linearly detrend the time use categories, roughly 4.2 percent of foregone market work hours are allocated to job search. As we discuss below, however, both for job search and for other income-generating activities the estimates increase significantly when we instrument changes in market work hours with the state-level unemployment rate. Therefore, we cannot reject the hypothesis that measurement error can be an issue for job search and for work at the informal sector. Nonetheless, even our highest estimates for job search are not that surprising given the work of Krueger and Muller (2010) who find that the unemployed allocate a small fraction of their time to job search. Finally, we find that more than 5 percent of foregone market work hours are allocated to increased time spent on education and roughly 5 percent are allocated to increased time spent on own medical care.

In our base estimates of Table 3 we clustered errors at the state level. However, the errors in our model could also be correlated across states. To address this concern, we have used panel-corrected standard errors. We report our results in Table B.6 of the online Appendix. Specifically, first we assume that the errors are heteroscedastic but uncorrelated across states. Second, we assume that errors are both heteroscedastic and correlated across states. Finally, we fit a panel-specific AR(1) process and simultaneously allow errors to be both heteroscedastic and correlated across states. In other words, we allow errors to be correlated both in the cross section and in the time series dimension of our panel. As we show in the online Appendix, our base standard errors do not change in any meaningful way when allowing for all these alternative correlation structures for the error term.

IV. Exploring the Cross State Results

In this section we expand upon our base results. First, we decompose the fraction that each time use category absorbs when market work hours decrease into a component due to changes across labor market states and a component due to changes within a labor market state. Second, we discuss measurement error, which in our sample is not of the classical form. Moreover, we explore the stability of our results over various subperiods. Next, we discuss gender and family effects. Finally, we present a number of additional sensitivity exercises.

A. *Decomposition Across and Within Labor Market States*

In the benchmark results reported in Table 3, foregone market work hours are treated symmetrically whether they represent changes in the intensive or extensive margins of employment. In this subsection, we explore whether changes in market

work hours conditional on employment (the intensive margin) differ from those reflecting changes in employment status (the extensive margin) in their implications for alternative time use categories.

To set notation, let p_t^E denote the fraction of the population that is employed in period t, and let h_t denote the average market work hours per employed person in period t. By definition, we have

$$\Delta\tau_t^{market} = \tau_t^{market} - \tau_{t-1}^{market} = p_t^E h_t - p_{t-1}^E h_{t-1}. \tag{3}$$

To estimate the relative importance of changes in the intensive versus extensive margins, we define ΔI_t and ΔE_t as follows:

$$p_t^E h_t - p_{t-1}^E h_{t-1} = \underbrace{\left(\frac{p_t^E + p_{t-1}^E}{2}\right)(h_t - h_{t-1})}_{\Delta I_t} + \underbrace{\left(\frac{h_t + h_{t-1}}{2}\right)(p_t^E - p_{t-1}^E)}_{\Delta E_t}. \tag{4}$$

That is, ΔI_t is the change in average market work hours conditional on employment scaled by the average employment share across the respective periods, while ΔE_t is the change in fraction employed scaled by average market work hours of the employed. By construction, $\Delta\tau_t^{market} = \Delta I_t + \Delta E_t$.

Between 2006–2008 and 2009–2010, aggregate market work declined by 2.11 hours per week (column 4 of Table 1). Of this change, 0.54 hours (or 25.6 percent) is accounted for by ΔI and 1.57 hours (or 74.4 percent) is accounted for by ΔE. Our benchmark estimates restrict the response of alternative time uses to changes in market work hours to be equal across changes due to the intensive and extensive margins of market work hours. Under this restriction, the contribution of the intensive margin between 2006–2008 and 2009–2010 would be 25.6 percent of the total implied change in each time use category and the contribution of the extensive margin would be 74.4 percent of the total. We report this restricted decomposition in the first four columns of Table 4. In particular, column 1 repeats the benchmark sensitivities from column 6 of Table 3. Column 2 reports the implied change in each time use given the 2.11 hours-per-week decline in total market hours. Column 3 reports the contribution due to the intensive margin and column 4 reports the contribution due to the extensive margin.

In principle, the response of time use categories to changes in market work hours could differ according to whether changes are in the intensive or extensive margin. We therefore consider an unrestricted specification in which the effect on time use category j of changes in market work hours in the intensive margin $\left(\beta_I^j\right)$ may differ from the effect in the extensive margin $\left(\beta_E^j\right)$. That is, we relax the restriction that $\beta^j = \beta_I^j = \beta_E^j$.

To estimate β_I^j, we construct a state-level sample based on the employed respondents only, and therefore all variation in market work hours is due to the intensive margin. Similarly to column 1 of Table 4, our specification includes the demographic controls. With $\hat{\beta}_I^j$ in hand, we decompose $\hat{\beta}^j \Delta\tau_t^{market}$ into the contribution due to the $\hat{\beta}_I^j \Delta I_t$ component and the $\hat{\beta}_E^j \Delta E_t$ component. The latter component is computed as the residual. Column 5 shows the estimated coefficients for the intensive margin and column 6 shows the coefficients for the extensive margin. Comparing the

TABLE 4—STATE SAMPLE: DECOMPOSITION ACROSS LABOR MARKET STATES

Time use category	$\hat{\beta}$ (1)	Hours change (2)	Intensive restricted (3)	Extensive restricted (4)	$\hat{\beta}_I$ (5)	$\hat{\beta}_E$ (6)	Intensive unrestricted (7)	Extensive unrestricted (8)
Other income-generating activities	0.99	0.021	0.005	0.016	1.28	0.89	0.007	0.014
Job search	1.26	0.026	0.007	0.019	0.30	1.59	0.001	0.025
Child care	4.06	0.086	0.022	0.064	3.72	4.17	0.020	0.066
Nonmarket work	28.38	0.599	0.153	0.446	30.03	27.81	0.162	0.436
Core home production	10.79	0.228	0.058	0.170	10.80	10.78	0.058	0.170
Home ownership activities	6.78	0.143	0.037	0.106	7.30	6.60	0.039	0.104
Obtaining goods and services	5.84	0.123	0.032	0.091	8.89	4.79	0.048	0.075
Others care	4.95	0.104	0.027	0.077	3.03	5.61	0.016	0.088
Leisure	52.16	1.101	0.282	0.819	55.85	50.89	0.301	0.800
TV watching	12.60	0.266	0.068	0.198	10.21	13.42	0.055	0.211
Socializing	3.88	0.082	0.021	0.061	6.50	2.97	0.035	0.047
Sleeping	20.82	0.439	0.112	0.327	15.27	22.72	0.082	0.357
Eating and personal care	−1.23	−0.026	−0.006	−0.019	5.04	−3.38	0.027	−0.053
Other leisure	16.08	0.339	0.087	0.252	18.81	15.14	0.101	0.238
Other	13.12	0.277	0.071	0.206	8.72	14.63	0.047	0.230
Education	7.19	0.152	0.039	0.113	4.66	8.06	0.025	0.127
Civic and religious activities	2.10	0.044	0.011	0.033	2.24	2.05	0.012	0.032
Own medical care	3.81	0.080	0.021	0.059	1.81	4.49	0.010	0.070

Notes: The table presents decompositions of the change in market work between 2006–2008 and 2009–2010. Column 1 repeats the estimated coefficients $\hat{\beta}^j$ from regression (2) presented in column 6 of Table 3. Column 2 multiplies the coefficient in column 1 by the 2.11 decline in market work hours observed between 2006–2008 and 2009–2010 to show the allocation of foregone market work into the alternative time use categories. Columns 3 and 4 show the intensive margin and the extensive margin of the change shown in column 2, using the restricted decomposition imposing $\beta_I^j = \beta_E^j = \beta^j$. Column 5 reports the estimated coefficients $\hat{\beta}_I^j$ from repeating the base regression of column 1 on the sample of the employed, and column 6 recovers $\hat{\beta}_E^j$ from the accounting condition $\hat{\beta}^j \Delta\tau^{market} = \hat{\beta}_I^j \Delta I + \hat{\beta}_E^j \Delta E$. Columns 7 and 8 show the intensive and the extensive margin of the change shown in column 2, using this unrestricted decomposition.

estimated coefficients $\hat{\beta}_I^j$ and $\hat{\beta}_E^j$ to each other and to the restricted coefficients $\hat{\beta}^j$ in column 1, we see a remarkable stability of these coefficients for nonmarket work and leisure.[7] This finding implies that the responsiveness of time use to changes in market work is similar regardless if the changes in market work hours are driven by changes in the intensive margin or extensive margin. We show the contribution to each time use category from changes in the two margins in columns 7 and 8 of Table 4, respectively.

Finally, to corroborate our finding that the estimated responsiveness of time use to changes in market work hours is roughly equal along the two margins, we have repeated our regressions at the individual level controlling for the same demographic and educational variables as in our state-level dataset. Specifically, an estimation using individual data implies that 25.8 percent of a decline in market work hours is allocated to nonmarket work and 59.7 percent is allocated to leisure, roughly equivalent to the state-level estimates of 28.4 and 52.2 percent respectively. Conditional on

[7] We have formally tested the null hypothesis that the estimated coefficients are equal to each other, and we cannot reject the null at conventional levels for many time use categories.

being employed, 27.3 percent of a change on the intensive margin of market work is reallocated to nonmarket work and 60.7 percent is reallocated to leisure. These are also in line with the state-level estimates of 27.8 and 50.9, respectively. To summarize, estimates based on state-level variation as well as individual-level variation indicate that the reallocation of foregone market work hours is roughly equivalent across changes in the intensive and extensive margins of market work.

B. *Measurement Error*

Our results using the cross state variation are based on the aggregation of micro-level time use data at the state level. A potential concern with our methodology is that the ATUS dataset is not meant to be necessarily representative at the state level, and therefore that market work hours are measured with error at the state level. Additionally, the small sample size at the state level implies that individual-level reporting errors may not average out at the state level. Thus far we have addressed these issues by aggregating at the two-year level (to increase the number of respondents per state) and by weighting states by their population (to reduce dependence on smaller states which are more likely to be less than representative in the ATUS). In this section we further assess the extent to which measurement error can affect our results. Our conclusion is that in general our results are robust to measurement error.

Measurement error in changes in market work hours $\Delta\tau_{st}^{market}$ is not of the classical form. The reason is that time use categories add up to a constant. Therefore, if market work is measured with error, then at least one other time use category is necessarily also measured with error. This implies that both the explanatory variable and the outcome variable are potentially measured with error. The extent to which measurement error in changes in market work affects our results depends on how the measurement error is allocated across different time use categories. Heuristically speaking, if measurement error in changes in market work is allocated to the alternative time use categories in proportion to the true responsiveness of the alternative time use categories to changes in market hours (as measured by the population coefficient β^j), then our estimates remain unbiased. If measurement error in changes in market work is allocated disproportionately to specific time use categories, then these time use categories will appear more responsive over the business cycle relative to the true population coefficient. We formalize this intuition in the Appendix.

Since there is no guarantee that measurement error in changes in market work is allocated to the various time uses in proportion to the true responsiveness of each time use, we assess empirically whether measurement error is an important concern for our estimates. We provide two robustness checks. First, we reweight all individual observations so that when we aggregate the ATUS sample at the state level we reproduce the official state-level unemployment rate as reported by the BLS.[8] This helps us address measurement error because the ATUS may oversample

[8] In state s and in period t, let w_{ist}^u be the weight given by the ATUS to an unemployed individual, let w_{ist}^e be the weight given by the ATUS to an employed individual, and let w_{ist}^o be the weight given by the ATUS to the remaining respondents (out of the labor force). Then, we use the new weights $q_{ist}^e = w_{ist}^e$, $q_{ist}^o = w_{ist}^o$ and

or undersample the unemployed at the state level. Second, we instrument the change in market work with the change in the state-level unemployment rate as reported by the BLS. By isolating the component of the change in market work hours correlated with the change in the official unemployment rate, we address measurement error due to the fact that the ATUS may not measure market work hours in a representative way at the state-period level. We present our results in Table 5. The estimates are in general more noisy, but the estimated coefficients do not change much in magnitude. In particular, nonmarket work absorbs roughly 26 percent of the foregone market work hours and leisure absorbs roughly 55 percent. A significant difference relative to our earlier results is the behavior of other income-generating activities and job search. When we instrument changes market work with changes in the state-level unemployment rate, other income-generating activities absorb roughly 3 percent and job search absorbs roughly 6 percent of the foregone market work hours.

C. *Results from Different Subperiods*

In this subsection, we explore the stability of our estimates across different subperiods. Given the size of the negative market work hours during the recent recession, it is conceivable that the allocation of foregone work hours to alternative time uses may have changed relative to earlier periods. For example, the marginal individual who experiences a decline in work hours during the recession may have different preferences for leisure or home production from the marginal individual who experiences a decline in work hours during the nonrecessionary periods. Alternatively, given that the aggregate economic environment is different, an individual who experiences a decline in work hours may choose to allocate their time to different activities when the economy as a whole is in a deep recession relative to a smaller recession.

To explore the stability of our estimates over different time periods, Table 6 repeats regression (2) separately for each subperiod. These regressions are weighted and include the vector of the demographic controls, as in column 6 of Table 3. Columns 1–3 show the results from the regressions for the most recent time period, the prerecessionary period, and the early time period respectively. Column 4 reports the *p*-value of the difference in estimates from the recent period relative to the early period. The last column reports the *p*-value of the difference in the estimates from the recent period relative to the prerecessionary period.

A few things are noticeable from Table 6. First, the responsiveness of changes in nonmarket work time to changes in market work time is the highest during the most recent (recessionary) time period. In particular, during the recession, 38 percent of foregone market work hours are allocated to nonmarket work. This is roughly 6 percentage points larger than the estimated response from the early subperiod and roughly 20 percentage points larger than the response from the prerecessionary subperiod. Likewise, the responsiveness of changes in leisure is the lowest during the recessionary period. Only 42 percent of foregone market work hours during the 2009–2010 period are allocated to leisure. This is roughly 6 percentage points lower

$q^u_{ist} = w^u_{ist} \sum_i w^e_{ist} u_{st} / \sum_i w^u_{ist}(1 - u_{st})$, where u_{st} denotes the BLS unemployment rate of state s in some period t. In the reweighted state-level sample the unemployment rate equals $\sum_i q^u_{ist} / (\sum_i q^u_{ist} + \sum_i q^e_{ist}) = u_{st}$.

TABLE 5—STATE SAMPLE: MEASUREMENT ERROR

Time use category	$\hat{\beta}$ Reweighted sample (1)	SE (2)	$\hat{\beta}$ Instrumental variables (3)	SE (4)
Other income-generating activities	0.16	0.52	3.05	1.91
Job search	0.44	0.72	6.20	2.75
Child care	−2.00	3.16	0.38	4.71
Nonmarket work	26.17	8.36	25.75	9.48
Core home production	10.38	2.67	9.62	7.42
Home ownership activities	6.46	6.41	4.94	5.95
Obtaining goods and services	4.97	1.96	−3.53	6.29
Others care	4.35	2.74	14.72	3.93
Leisure	58.90	9.39	53.99	11.70
TV watching	9.27	5.54	19.85	10.63
Socializing	7.19	4.76	1.38	7.56
Sleeping	19.09	5.79	38.16	11.48
Eating and personal care	1.06	2.19	−1.59	4.86
Other leisure	22.27	5.94	−3.81	8.29
Other	16.30	5.26	10.60	9.11
Education	10.14	5.39	4.62	6.89
Civic and religious activities	0.61	2.19	−0.46	3.75
Own medical care	5.55	1.64	6.44	3.91

Notes: The table presents sensitivity analysis of the baseline regression in column 2 of Table 3 to measurement error. All coefficients are multiplied by 100. Column 1 presents estimates when the underlying ATUS sample is reweighted so that in the state-level sample the unemployment rate at the state-period level exactly reproduces the official BLS state unemployment. Column 2 presents the standard errors associated with the estimated coefficients of column 1. Standard errors are clustered at the state level. Column 3 presents estimates in the original state-level sample (similar to the sample used in Table 3), when changes in market hours are instrumented with changes in the state-level unemployment rate as given by the BLS. The *F*-statistic of the first stage regression of changes in market work on changes in the state-level unemployment rate is 19.77. Column 4 presents GMM standard errors associated with the estimated coefficients of column 3. Standard errors are clustered at the state level.

than what was estimated for the first subperiod and roughly 20 percentage points lower than what was estimated for the second subperiod.[9]

Second, our results indicate that the first period is much more similar to the recessionary period than the second period with respect to the reallocation of foregone market work hours. The *p*-value for the null hypothesis that the response of nonmarket work is not different between the early and the recent period is 0.525, and the *p*-value for the hypothesis that the response of leisure is not different between the early and the recent period is 0.592. We view this as a reassuring result given that, arguably, much of the variation of changes in market work across states during the early period was also due to business cycle variation with the aggregate

[9] Including into the base specification in column 6 of Table 3 the interaction of changes in market work with the aggregate level of market work, we find that a larger fraction of foregone market work hours is allocated to nonmarket work and a smaller fraction to leisure when the economy is depressed. Specifically, a one-hour decrease in aggregate market work is associated with a 6.2 percentage point increase in the estimated responsiveness of changes in nonmarket work. By contrast, a one-hour decrease in aggregate market work is associated with a 6.7 percentage point decrease in the estimated responsiveness of changes in leisure.

TABLE 6—STATE SAMPLE: RESULTS BY SUBPERIODS

Time use category	2010–2009 Estimate	2008–2007 Estimate	2006–2005 Estimate	2010–2009 versus 2006–2005 *p*-value	2010–2009 versus 2008–2007 *p*-value
Other income-generating activities	2.93	0.09	−1.66	0.001	0.018
Job search	0.11	−1.06	1.87	0.292	0.536
Child care	9.04	6.67	−1.47	0.012	0.488
Nonmarket work	37.86	18.02	32.04	0.525	0.001
Core home production	14.19	12.72	5.84	0.205	0.802
Home ownership activities	5.58	1.08	16.01	0.006	0.167
Obtaining goods and services	12.77	1.54	7.55	0.410	0.012
Others care	5.31	2.67	2.62	0.370	0.313
Leisure	42.33	63.29	48.31	0.592	0.018
TV watching	5.81	23.37	3.05	0.758	0.020
Socializing	6.33	−3.94	8.50	0.764	0.037
Sleeping	14.16	27.42	18.96	0.651	0.123
Eating and personal care	0.01	−4.25	3.81	0.543	0.424
Other leisure	16.02	20.68	13.97	0.789	0.534
Other	7.69	12.97	20.90	0.077	0.443
Education	1.79	7.90	13.51	0.086	0.310
Civic and religious activities	−1.59	4.92	3.98	0.093	0.035
Own medical care	7.50	0.13	3.39	0.184	0.002

Notes: The table presents the estimated coefficients $\hat{\beta}^j$ from regression (2) in different subperiods using weighted least squares. All coefficients are multiplied by 100. All columns include the demographic controls. Column 1 presents estimates using the change in time use categories only between 2008–2007 and 2010–2009. Column 2 presents estimates using the change in time use categories only between 2006–2005 and 2008–2007. Column 3 presents estimates using the change in time use categories only between 2004–2003 and 2006–2005. Column 4 presents the *p*-value associated with the null hypothesis that the estimated coefficients in columns 1 and 3 are not different from each other. Column 5 presents the *p*-value associated with the null hypothesis that the estimated coefficients in columns 1 and 2 are not different from each other. All *p*-values are based on statistical tests using standard errors clustered at the state level.

unemployment rate falling from roughly 6 percent to roughly 4.5 percent.[10] While not conclusive, this suggests that our findings may extend to other periods of high aggregate volatility outside of the current recession.

Third, the estimates are much lower for the response of nonmarket work and much higher for the response of leisure during the 2005–2008 period. The *p*-value for the null hypothesis that the response of nonmarket work is not different between the recent and the prerecessionary period is 0.001, and the *p*-value for the null hypothesis that the response of leisure is not different between the recent and the prerecessionary period is 0.018. This result suggests that one should be cautious when using the cross state estimates from nonrecessionary periods to predict how time use will respond to foregone work hours during recessions.

D. *Gender and Family Effects*

In this subsection we extend our results to examine how our estimates vary by gender and family status. We start with the most encompassing specification with

[10] We acknowledge the possibility that measurement error at the state level could be larger before the recession, and this causes the coefficients to differ across subperiods. The lack of sufficient power does not allow us to investigate this hypothesis further using the instrument of Section IVB.

TABLE 7—STATE SAMPLE: FURTHER ROBUSTNESS

Time use category	Demo + D_t (1)	Men (2)	Women (3)	Married (4)	Married (spouse) (5)	Singles (6)	Housing (7)	Instrument (8)
Other income-generating activities	0.82	0.94	1.24	−0.18	−0.22	0.69	0.91	−4.10
Job search	0.73	1.37	0.90	0.37	1.18	1.06	0.74	−4.35
Child care	4.98	3.07	5.79	8.17	7.88	−0.24	4.45	2.34
Nonmarket work	29.68	28.80	26.27	34.36	31.90	15.51	28.93	32.67
Core home production	11.80	7.82	12.84	14.57	15.75	10.00	10.96	6.08
Home ownership activities	7.47	8.34	5.42	9.87	6.53	3.70	7.02	13.79
Obtaining goods and services	6.61	8.66	8.23	7.28	7.84	0.26	7.41	7.53
Others care	3.78	3.96	−0.23	2.62	1.77	1.53	3.53	5.26
Leisure	51.09	55.83	62.66	50.61	53.54	63.64	52.05	49.00
TV watching	12.35	19.30	12.19	16.90	12.31	13.59	13.40	35.15
Socializing	3.24	7.81	3.72	5.61	5.30	5.05	2.47	10.26
Sleeping	19.42	11.71	23.78	13.13	14.31	27.24	19.33	13.61
Eating and personal care	−1.81	0.51	0.95	−0.99	2.87	−0.33	−1.38	−7.01
Other leisure	17.89	16.48	22.00	15.55	18.72	18.11	18.22	−3.00
Other	12.68	9.95	3.12	7.39	5.69	19.33	12.90	24.43
Education	6.44	6.28	−1.86	0.92	0.16	13.47	7.67	−0.10
Civic and religious activities	2.14	−1.64	4.14	2.25	0.93	1.80	1.66	6.36
Own medical care	4.09	5.31	0.83	4.20	4.60	4.04	3.55	18.17

Notes: The table presents the estimated coefficients $\hat{\beta}^j$ from regression (2). All coefficients are multiplied by 100. Column 1 repeats column 8 of Table 3 with demographic controls and time dummies. Columns 2 and 3 present the same specification as in column 1, but in the sample of men and women respectively. Columns 4, 5, and 6 present the same specification as in column 1, but in the sample of married, married whose spouse is employed, and singles respectively. In column 5 we also introduce changes in spouse's market work hours as an additional control. Column 7 repeats the specification of column 1 with the addition of two controls, the change in homeownership rates and the change in housing prices. Column 8 presents instrument variable estimates. See the text for a description of the instrument.

demographic controls and time dummies (column 8 of Table 3) which we repeat as column 1 of Table 7 to ease the comparison. In columns 2 and 3 of Table 7 we repeat the base specification separately for the sample of men and for the sample of women. In general, the patterns of men and women look similar and in most cases we fail to reject at the 10 percent level of significance the hypothesis that men's and women's time use respond similarly when market work decreases. There are some notable exceptions. In particular, in the sample of women more of the reduced market work hours are allocated to core home production activities (e.g., cooking, cleaning, laundry) and sleep. By contrast, in the sample of men a larger fraction of foregone market work hours are allocated to TV watching and education.

In columns 4, 5, and 6 of Table 7 we split the sample between married and singles. As the columns show, there are intuitive differences between married and singles. Specifically, in column 4 married allocate 34 percent of their foregone market work hours to nonmarket work and an additional 8 percent to child care. A well known limitation of the ATUS sample is that it samples only one individual per household, which makes the analysis of family effects less than ideal. Nonetheless, the ATUS provides an indicator of the employment status of the spouse and an estimate of the market work hours of the spouse. In column 5 we focus on the sample of married whose spouse is employed. We, additionally, include in the base specification the change in market work hours of the spouse. As column 5 shows, conditioning on the work hours of the spouse does not significantly change the results for married individuals. This is because changes in market work hours across spouses are weakly correlated in our sample.

By contrast, in column 6 singles allocate only 15 percent of foregone market work hours to nonmarket work and zero to child care, while they allocate more than 60 percent of their foregone market work hours to leisure (with the difference relative to the married being almost entirely accounted for by sleeping). Interestingly, singles do not seem to spend more time searching for a job, but they do spend significantly more of their foregone market work time on education.[11]

E. *Further Sensitivity Exercises*

In this subsection we briefly discuss various additional robustness exercises. We start with the most encompassing specification with demographic controls and time dummies (column 8 of Table 3) which we repeat as column 1 of Table 7 to ease the comparison. In column 7 of Table 7, we introduce in the base specification state-level economic controls that proxy for potential shocks to the home production sector. The recent recession is also associated with big changes in the fraction of the population owning a home. If homeownership is associated with increased home production, changes in homeownership rates or the desire to maintain a home could bias our results. To help to control for this potential problem, we include the change in the state homeownership rate between $t-1$ and t and the change in housing prices at the state level between $t-1$ and t as additional regressors.[12] As column 7 shows, our results do not change in any meaningful way relative to the base results.

In column 8 of Table 7 we instrument changes in market work hours at the state level with a proxy of local labor demand shocks. With this exercise we explore the allocation of time over the business cycle when the variation of changes in market work hours across states is caused by shocks that are similar to the shocks most likely to cause business cycles at the aggregate level. The base specification, by contrast, is agnostic to the causes of the cross-sectional variation in our sample. The instrument we consider is

$$\Delta \tau_{st}^{market,\,\mathrm{IV}} = \Delta \sum_{k} \left(\frac{emp_s^k}{emp_s} \right) u_{st}^k, \tag{5}$$

where s denotes the state, t denotes the period, k denotes the industry, emp denotes employment, and u denotes the unemployment rate. The instrument is the sum across industries of the interaction between a time-invariant industry share in state s and the national unemployment rate in industry k in period t. The share emp_s^k/emp_s denotes the average employment share of industry k in state s and is estimated using CPS data between 1977 and 2002. The national unemployment rate in industry k is indexed by s because we exclude state s from its calculation. As column 8 shows, our results regarding large aggregate categories (nonmarket production, leisure, and

[11] When we condition on the sample of singles who have children, we find similar responsiveness in terms of leisure. Singles with children, however, allocate 10 percent more of their increased time to nonmarket work and child care relative to singles in general. By contrast, singles in general allocate more than 10 percent of their increased time to education, whereas singles with children allocated none of their increased time to education.

[12] The homeownership rate by state is calculated using data from the US census (see Table 14 at http://www.census.gov/housing/hvs/data/histtabs.html). Housing prices by state are calculated from the Federal Housing Finance Agency (see http://www.fhfa.gov/Default.aspx?Page=87).

other) remain robust. However, the more disaggregated categories become more noisy relative to the benchmark.

Finally, we examine the robustness of our results to the construction of the underlying sample and we also examine specifications with state-specific fixed effects and state-specific time trends. These results are presented in the online Appendix (Table B.7). All of the robustness exercises yield results similar to the results in our base case specification. To summarize, first we estimate equation (2) using one-year time periods as opposed to the two-year time periods we used in our base specifications. Second, we estimate the regression when the underlying state-level data is constructed based on the sample of respondents of all ages (instead of only ages 18–65) whose answers could be classified by the ATUS stuff. Third, we estimate the regression when the underlying state-level data is constructed based on the full ATUS sample, including respondents whose answers could not be classified by the ATUS staff. Fourth, we estimate the regression including state-specific fixed effects. State-specific fixed effects in a differenced equation are equivalent to state-specific linear trends in a levels equation and capture differential average changes in each time use category across states. Fifth, we go a step further and estimate the regression introducing state-specific linear time trends (i.e., interactions of state-specific fixed effects with a linear time trend) in each time use category. State-specific linear time trends in a differenced equation are equivalent to a nonlinear state-specific trend in a levels equation. Across all these robustness exercises, we find that roughly 26–32 percent of foregone market work hours are allocated to nonmarket production while roughly 40–56 percent of foregone market work hours are allocated to leisure.

V. Implications for Macroeconomic Models

Early dynamic general equilibrium models assumed that any time not working is by definition spent on leisure. Models introducing home production as a third activity, such as that of Benhabib, Rogerson, and Wright (1991) and Greenwood and Hercowitz (1991), were successful in explaining a number of stylized facts of aggregate fluctuations that were hard to generate using the early models. There are two reasons why home production can make a difference for these models. First, shifts in relative prices cause households to substitute goods and time not only intertemporally between periods but also intratemporally between the market and the home sector. Intratemporal substitution introduces a powerful amplification channel to hours worked in response to changes in market productivity which is absent from the standard real business cycle model. Second, when individuals derive utility both from market-produced goods and from home-produced goods, volatility in goods and labor markets arises because of relative productivity differences between the two sectors, and not solely because of productivity shocks in the market sector as in the one-sector model.

The first central issue of models with home production is that they typically assume a high degree of substitution of time between the market and the home sector over the business cycle. Until today, there has been no systematic evidence that the substitution of time across sectors in these models is consistent with the actual behavior of the households during recessions. Our result that nonmarket work absorbs roughly one-third of the shock in market work hours while leisure absorbs

roughly one-half of the shock in market work hours implies that nonmarket work is a much more elastic margin of substitution than leisure at business cycle frequencies. This is because nonmarket work accounts for only roughly 11 percent of the total time endowment, whereas leisure occupies 65 percent of the total time endowment. More formally, we estimate the elasticity of time use category j with respect to market work as $e^j = \hat{\beta}^j \tau^{market}/\tau^j$, where τ^j denotes the average time spent on time use j, τ^{market} denotes the average time spent on market work, and $\hat{\beta}^j$ denotes the estimated responsiveness of time use j to changes in market work time. Using the base estimates of column 6 of Table 3, we find that the elasticity of nonmarket work is roughly 0.50. By contrast, the elasticity of leisure is roughly 0.15. In other words, when market work hours fall by 10 percent, nonmarket work hours increase by 5 percent while leisure hours increase by 1.5 percent.

These estimates are supportive of business cycles models with a high elasticity of substitution between the market and the home sector. In the working paper version of this article (Aguiar, Hurst, and Karabarbounis 2011) we showed that the Benhabib, Rogerson, and Wright (1991) model is consistent with the movements in nonmarket work and leisure in the ATUS dataset under a 2.5 elasticity of substitution between market-produced and home-produced goods.[13] The home production model with a high elasticity of substitution has been used successfully to address a number of business cycle puzzles. Benhabib, Rogerson, and Wright (1991) and Greenwood and Hercowitz (1991) show that home production increases the volatility of market work and consumption relative to output and lowers significantly the correlation between productivity and market work. McGrattan, Rogerson, and Wright (1997) discuss fiscal policies in an estimated model with home production. Canova and Ubide (1998) show that home production helps lower the international correlation of consumption. Baxter and Jermann (1999) show how home production can generate "excess sensitivity" of consumption to predictable income changes. Karabarbounis (2012) discusses the determination of real exchange rates in a model with a home sector and shows that home production helps to explain why real exchange rates are uncorrelated with the ratio of consumption across countries.

Additionally, some researchers have recently modeled business cycle movements in aggregate consumption and aggregate market work by assuming households have non-separable preferences between market consumption and market work. Hall (2009a), for instance, examines unemployment dynamics in a model in which consumption and labor are complements. Preferences as in Greenwood, Hercowitz, and Huffman (1988) have been extensively used to improve the predictions of open economy models (e.g., see Mendoza 1991, and Correia, Neves, and Rebelo 1995). Recently, Monacelli, and Perotti (2008), Hall (2009b), Christiano, Eichenbaum, and Rebelo (2011), and Nakamura and Steinsson (2011) have emphasized the implications of the complementarity between consumption and labor in the utility

[13] Our estimates are consistent with other estimates in the literature. Based on macro data and likelihood methods, McGrattan, Rogerson, and Wright (1997) estimate this elasticity to be slightly less than 2, while Chang and Schorfheide (2003) estimate it to be roughly 2.3. Using micro data, Rupert, Rogerson, and Wright (1995) estimate a value of 1.8 and Aguiar and Hurst (2007b) estimate a value of roughly 2. Karabarbounis (2012) shows that a value of 4 explains the volatility of the wedge between the marginal product of labor and the marginal rate of substitution (the "labor wedge") at business cycle frequencies, while the home production model with an elasticity of substitution of 2.5 generates roughly two-thirds of the labor wedge's volatility.

function for the government spending multiplier, in both neoclassical models and in New-Keynesian models with price rigidities. Our finding that home production is elastic at business cycle frequencies is supportive of models which assume strong complementarities between market consumption and market work in the utility function. This is because the home production model with high substitutability between market consumption and home consumption nests a reduced-form model without home production but in which market consumption and market work are strong complements in the utility function.

The second central issue in models with home production, and in some models with non-separable preferences between consumption and labor, is the existence of taste shocks that affect directly the marginal rate of substitution between consumption and work. In a world with stable preferences and no changes in the parameters of the home sector, a model with non-separable preferences between market consumption and home production nests a reduced-form model with non-separable preferences between market consumption and labor. However, when home production technologies, housing capital, or government policies which affect the incentive of households to work in the home sector evolve over time, the two models are only similar if preferences over consumption and labor are not stable over time.[14] Our results show that the home production sector is a viable margin of substitution even at business cycle frequencies. If the home sector is truly important and if that sector experiences evolving technologies, capital, or sector-specific policies, models without home production must allow households to receive shocks to their valuation of consumption relative to labor over time.

The second issue we address is whether home production shocks are important drivers of aggregate market work between 2003 and 2010. To do this, we estimate the relationship between aggregate state market work and individual nonmarket work hours, holding constant individual market work hours. Specifically, we consider the following regressions at the individual level:

$$(6) \quad \tau_{ist}^{nonmarket} = \alpha_m - \beta_m^h \tau_{ist}^{market} + \gamma^h A_{st} + \mathbf{D}_t + \mathbf{S}_s + \delta_m^h \mathbf{X}_{its} + \varepsilon_{ist}^h,$$

where $\tau_{ist}^{nonmarket}$ denotes nonmarket work hours of individual i in state s in time t, τ_{ist}^{market} denotes market work hours of the individual, $\mathbf{D}_t$ and $\mathbf{S}_t$ are year and state dummies, $\mathbf{X}_{ist}$ denotes a vector of demographic and educational variables, and A_{st} denotes some measure of aggregate market conditions at the state level. For our regressions we consider $A_{st} = \tau_{st}^{market}$ or $A_{st} = u_{st}$, where τ_{st}^{market} denotes average market work hours in state s in time t and u_{st} denotes the state-level unemployment rate from the BLS.

For the regression using τ_{st}^{market}, a negative estimated coefficient γ^h implies that individuals spend more time on nonmarket work when aggregate market work hours decrease, holding constant their market work hours. This would suggest that individuals experience positive shocks to their nonmarket work time in periods of decreasing aggregate market work. For the regression using u_{st}, a positive estimated coefficient γ^h implies that individuals spend more time on nonmarket work when

[14] See Greenwood, Seshadri, and Yorukoglu (2005) for an example of technology shocks in the home sector.

aggregate unemployment is high, holding constant their market work hours. This would suggest that individuals experience positive shocks to their nonmarket work time in periods of increasing aggregate unemployment. In both cases, this would imply the existence of positive home production shocks during recessions.

For the regression using τ_{st}^{market}, the estimated coefficient γ^h is -0.016 with an estimated standard error of 0.023. The economic significance of this coefficient is small, considering that a one-hour decline of market work hours at the individual level is associated with a more than 25 percent increase in nonmarket work ($\beta_m^h = 0.258$). In other words, individuals adjust their home production time when their market work changes, but they do not appear to adjust their home production time systematically with aggregate market work hours conditional on their market work hours. For the regression using u_{st}, the estimated coefficient γ^h is -0.051 which is also not statistically significant at the 10 percent level (standard error of 0.082). Therefore, we conclude that the correlation between home production shocks and state-level market conditions is, at best, weak.[15] When we repeat the same regressions for the employed respondents only, we again find close to zero and statistically insignificant coefficients.

Finally, we have also repeated these regressions for other time use categories. The two statistically significant results that come out are for own medical care and leisure with respect to changes in aggregate market work hours. Specifically, a one-hour decline of market work hours at the state level is associated with a 0.018 hour increase in time spent on own medical care and with a 0.059 decrease in time spent on leisure. Both coefficients are, however, of moderate economic significance. To summarize, our results suggest that the variations in time use we observe in our 2003–2010 sample are solely because of changes in market work time.

VI. Conclusions

Using data from the ATUS, we explore how households allocate their time over the business cycle. To distinguish business cycle effects from low frequency trends, we use the cross state variation with respect to the severity of the business cycle to identify how market work time is reallocated to different time uses over the business cycle.

We find that roughly 30 percent of the foregone market work hours are allocated to increased nonmarket work and another 5 percent to increased child care. Our results are in general supportive of workhorse macroeconomic models with home production. This is because our estimates suggest that home production is a very elastic margin of substitution at business cycle frequencies, in line with the assumption underlying business cycle models with home production. These models are also important because they provide micro-foundations for reduced-form models in which consumption and labor enter as complements in the utility function. By contrast, we do not find evidence consistent with the existence of positive home production shocks when aggregate market work hours are low. We emphasize, however,

[15] When we omit the time dummies, so that we include the variation within state across time in our sample, the estimated coefficient for aggregate market work increases to 0.001 with a standard error of 0.021, and the estimated coefficient for the unemployment rate decreases to -0.20 with an estimated standard error of 0.043.

that the usefulness of home production models does not rest solely on the existence of shocks in the home sector. Introducing a home sector into business cycle models provides a powerful amplification mechanism for various macroeconomic variables of interest, such as labor supply and consumption, irrespective of the existence of shocks to the home sector.

Leisure absorbs more than 50 percent of foregone market work hours, with sleeping time and television watching accounting for roughly two-thirds of this increase. Given the large movements in the time allocated to these two categories, our results suggest that economists need to think hard how individuals value the marginal time spent sleeping or watching television when computing the welfare costs of business cycles. On the other hand, we find that job search and work in the informal sector absorb small fractions of the foregone market work hours. Our results regarding job search should be informative for a large class of unemployment models over the business cycle.

Other investments (education, health care, civic activities) account for more than 10 percent of the foregone market work hours. It is not clear from the data available how much of the increased time spent on medical care is the result of increased preventive maintenance and how much is it increased medical shocks associated with the recession. Moreover, the data cannot differentiate how much of the increased time spent on human capital development represents investments that would have never occurred absent the recession versus investments that have been moved forward given the individual's temporary low opportunity cost of time. Given the large movements of time into these activities, it is important to understand how much of this reallocation contributes to the long-run stock of human capital.

We find that the responsiveness of time use to changes in market work is stable across labor market states. In particular, we find that the reallocation of time is not sensitive to whether the additional time represents changes in market hours on the intensive versus extensive margins. While this distinction is important in many contexts, our estimates suggest that it is not relevant for the reallocation of time across nonmarket activities in the latest recession. On the other hand, our results show interesting differences in the allocation of time by marital status. Our results imply that introducing differential responsiveness of married versus singles to market work shocks may be a fruitful exercise.

Appendix

In this Appendix we derive formally the bias of the OLS coefficient in our model in which all time use categories exhaust the time constraint. Let $i = 1, \ldots, I$ denote the number of observations, let $\Delta\tau_i^{market}$ denote the change in market work and let $\Delta\tau_i^j$ denote the change in time use category j. The time constraint implies

$$\Delta\tau_i^{market} + \sum_j \Delta\tau_i^j = 0, \quad \forall i = 1, \ldots, I. \tag{A1}$$

For expositional ease we assume that all variables have zero mean. We write the true model as

$$\Delta\tau_i^j = -\beta^j \Delta\tau_i^{market} + \varepsilon_i^j, \tag{A2}$$

where ε_i^j is orthogonal to $\Delta\tau_i^{market}$. Suppose that the observed change in market work $\Delta\tilde{\tau}_i^{market}$ is a noisy measure of the true change in market work $\Delta\tau_i^{market}$:

$$\Delta\tilde{\tau}_i^{market} = \Delta\tau_i^{market} + m_i, \tag{A3}$$

where m_i denotes the measurement error. We assume that m_i has zero mean, has variance $\text{var}(m)$ and is uncorrelated with the true change in market work $\Delta\tau_i^{market}$. If the measurement error m_i was uncorrelated with ε_i^j and hence with $\Delta\tau_i^j$, then we would obtain the classical measurement error bias and the OLS coefficient would be

$$\beta_{OLS}^j = \frac{\text{cov}\left(-\Delta\tilde{\tau}^{market}, \Delta\tau_i^j\right)}{\text{var}(\Delta\tilde{\tau}^{market})} = \beta^j \frac{\text{var}(\Delta\tau^{market})}{\text{var}(\Delta\tau^{market}) + \text{var}(m)}. \tag{A4}$$

As it is well known, classical measurement error attenuates the estimated coefficients toward zero. In our case, however, measurement error in changes in market work m_i has to be allocated to changes in other time use categories $\Delta\tau_i^j$ since the time constraint (A1) always holds. Therefore, m_i is not uncorrelated with $\Delta\tau_i^j$. Let f_i^j be the fraction of the measurement error in changes in market work that is allocated to time use category $\Delta\tau_i^j$, with $\sum_j f_i^j = 1, \forall i = 1, \ldots, I$. The econometrician observes

$$\Delta\tilde{\tau}_i^j = \Delta\tau_i^j - f_i^j m_i. \tag{A5}$$

Note that by construction $\Delta\tilde{\tau}_i^{market} + \sum_j \Delta\tilde{\tau}_i^j = 0, \forall i = 1, \ldots, I$. In that case, the OLS coefficient becomes

$$\beta_{OLS}^j = \frac{\text{cov}(-\Delta\tilde{\tau}^{market}, \Delta\tilde{\tau}^j)}{\text{var}(\Delta\tilde{\tau}_i^{market})} = \frac{\beta^j \text{var}(\Delta\tau^{market}) + \text{cov}(\Delta\tau^{market} + m, f^j m)}{\text{var}(\Delta\tau^{market}) + \text{var}(m)}. \tag{A6}$$

To understand the intuition of equation (A6), consider the simplifying assumption that f^j is constant. In this case, the allocation of the measurement error does not correlate with changes in market work or the measurement error itself. Under this assumption we obtain

$$\beta_{OLS}^j = \beta^j \left(\frac{\text{var}(\Delta\tau^{market})}{\text{var}(\Delta\tau^{market}) + \text{var}(m)} \right) + f^j \left(\frac{\text{var}(m)}{\text{var}(\Delta\tau^{market}) + \text{var}(m)} \right). \tag{A7}$$

Equation (A7) implies that when $\beta^j = f^j$, i.e., when the measurement error is allocated to the various time use categories in correspondence to how these time use categories respond to changes in market work in the true data generating process, then we can consistently estimate the true population coefficient with OLS (i.e., $\beta_{OLS}^j = \beta^j$). When measurement error in changes in market hours is allocated to a

time use category j by more than how much changes in market hours are allocated to the same time use category ($f^j > \beta^j$), then the OLS coefficient becomes upward biased in absolute value. The extent of the bias depends on the variance of the measurement error relative to the variance of changes in market hours. More in general, equation (A6) shows that the extent of the bias will depend on the specific covariation of the fraction of the measurement error allocated in a specific time use category with the change in market hours observed by the econometrician.

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